FM Broadcast Receiver Performance

in the proximity of

Stations on second adjacent channels

Prepared at the request of

Claudio Lisman

By

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President
Wireless Spectrum Resources, Inc.

INTRODUCTION

This report is in response to the recent Notice of Proposed Rule Making(NPRM) MM Docket No. 99-25, adopted by the Federal Communications Commission(FCC) proposing to create three classes of low power radio service, which will operate in the existing FM radio band.

One of the primary concerns that the FCC has expressed is interference to existing FM broadcast stations from the introduction of additional low power stations on frequencies as close as two(400 KHz) and three(600 Khz) channels from an existing station.

Wireless Spectrum Resources, Inc.(WSRI) was requested by Claudio Lisman to conduct a investigation into what would happen if stations were located only two channels apart.

The plan was to observe the performance of various consumer type of receivers when subjected to the different combinations of signal strength levels from stations on second adjacent channels. It was felt that the second adjacent channel performance tests would present a Aworst case≅ situation. The only requirement imposed on the selection of the receivers was that it had digital tuning to eliminate any error in tuning the receiver to the subject stations. The three receivers used in this project, the Sony 2010 was considered a older type of FM receiver, the Toyota 4-Runner receiver was considered a typical vehicle receiver and the Sony CFD-S38 was purchased as a representative of the receivers currently on the market.

PROCEDURE

The Miami market contains a unique FM station(WAEM), which is being used by the State of Florida and Miami-Dade County to provide information to foreign visitors who will be traveling around the Miami-Dade county area in rental vehicles. This station is located in the downtown area of the City of Miami and licensed to transmit with a Effective Radiated Power(ERP) of 25 watts at 100 Meters height above average terrain(HAAT) on a frequency of 102.3 MHz. Adjacent to this frequency is station WKLG at 102.1 MHz. at Rock Harbor approximately 50.3 miles from WAEM and on the second adjacent frequency of 102.7 MHz. is WMJX which is approximately 12.7 miles from WAEM. WKLG is a class C-2 station licensed for 50 KW ERP at 131 meters HAAT and WMJX is a class C station licensed for 100 KW ERP at 330 meters HAAT.

With WAEM adjacent to one station and two channels from another it was assumed that this would provide a good test situation for investigating second and third channel protections.

The goal of the investigation was to subject different consumer type of receivers to various signal strength level combinations from the stations involved and observe their performance. To obtain an idea of what field strengths were involved, signal strength measurements from the involved stations were made with a Potomac FIM-71 signal strength meter.

After making several measurements it was discovered that this scenario was not going to provide much data as the class C station was over loading the Potomac meter input and preventing

measurements of WEAM signal strength. Also the signal of the adjacent channel station was weak enough to also be overloaded by the stronger local signals 3 channels away.

What did come out of this exercise was the realization of how FM broadcast receivers preformed in various signal level environments. One receiver, purchased new for this investigation was found to have very poor selectivity and was easily overloaded by nearby strong stations. The best receiver was located in the investigator=s vehicle, a 1996 Toyota 4-Runner. At many sites where both other receivers failed, the 4-Runner receiver was able to receive WEAM with full quieting. (See Equipment list for description of receivers used.)

Since this scenario was not working out as planned, a review of the local market was conducted to determine if there were any stations located only two channels apart. Such a situation existed between station WAFG licensed at 90.3 MHz with a ERP of 3 KW at a HAAT of 85 meters licensed to Pompano Beach, Fl. and WXEL which is licensed at 90.7 MHz with a ERP of 25 KW at a HAAT of 107 meters licensed to Boynton Beach, Fl. approximately 27.39 miles from WAFG. (See attached map for exact locations of transmitters.)

Measurements were made at 18 random locations over a two day period. The latitude and longitude of each location was recorded using a GPS receiver so it could be plotted later on a map. At least three measurements using the FIM-71 were made at each location and averaged together to eliminate any local reflections ect. that might affect the measurements. All measurements were made at 7 feet above the ground and then corrected using the antenna factor supplied with the FIM-71 meter. Measurement locations selected were usually in open fields with no overhead power lines, nearby large buildings or trees.

Once the measurements were made with the FIM-71, each portable receiver was walked around the area where the measurements had been made. The vertical antennas for the portable receivers
was extended to its full length. The receiver performance was judged as it was walked around the area while being tuned to each station. The vehicle receiver was tuned to each station while parked and its performance was noted. The results of these test are contained in the attached map, charts and graphs.

A second test was conducted to find out how a Agood≅ receiver when tuned to a station two channels away would respond when situated in close proximity to a low power station. Using the receiver in the 4-runner, the vehicle was driven in the approximate directions of north, south, west and east from the lower power station WAFG while tuned to WXEL. Once the receiver received a clear WXEL signal, the location was noted and later mapped as shown in the attached map 2.

CONCLUSION

After the data was collected, locations were plotted on mapping software, distance from each station was calculated, then signal strength measurements were graphed based on distance from the transmitter and compared with the performance for each receiver used. (See Map of Measurement Locations for Study, Data lists & Graphs)

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From the data collected, it is clear that the full power stations have little to worry about from the low power stations.

Receiver selectivity makes a big difference in how much the second adjacent stations interfere with each other.(See Graphs) In the scenario presented, the low power station was assumed to be operating at its licensed power of 3KW ERP and the higher power station was operating at 25KW ERP, approximately 1:10 ratio, when applied to the proposed rule making, this could become a 1:100 ratio.(1KW ERP vs 100 KW ERP) thus the differences found in this report would be much more pronounced and the interference to the full power station will be much less.
From the measurements conducted, most of the time the full power station was received without any interference even when within a couple of miles of the low power station. Only when within 1 mile of the low power station did a Agood≅ receiver suffer from overload and was not able to receive the stronger station.(See Map 2) Hopefully when the Inband Digital Transmission Systems are implemented, the receivers will have a very good selectivity for receiving the appropriate station.

It will be to the LPFM applicants advantage to locate their stations as far as possible from a full power station on the second or third adjacent channel to maximize the LPFM station=s coverage area.

Thus based on the results presented here, the Federal Communications Commission can eliminate the current and proposed protection of full power FM stations from the operation of LPFM stations on second and third adjacent channels.

MEASUREMENTS ON 90.3 MHz
DISTANCE FROM STATION VS SIGNAL STRENGTH

(All values in uv/meter)

DISTANCE (bearing)	AVERAGE MEAS. VAL.	CORRECTED VAL.	RECEIVERS 1	2	3
1.78(17.57)	4470	10057.5	G	G	G
2.68(184.8)	2800	6300	G	G	G
3.4(83.8)	2566.6	5774.85	G	G	G
4.74(66.33)	586.7	1320	G	G	G
6.28(131.2)	673.3	1514.9	G	G	G
7.3(146.4)	220	495	G	G	G
7.31(187.6)	400	900	G	G	G
8.62(121.4)	233.3	524.9	G	G	F
9.6(134.2)	260	585	G	G	F
10.11(189.8)	240	540.0	G	G	N
10.31(152.2)	320	720	G	G	G
10.83(124.5)	183.3	412.4	G	G	S
11.42(180.6)	183.3	412.4	G	G	F
15.5(170.9)	76.6	172.3	N	G	S
16.92(188.4)	32.3	72.6	G	G	NS
17.91(164)	68.3	153.7	S	G	NS
24.18(168.7)	NOT MEAS.		S	F	NH

Receiver Notes: G- Good Reception, F - Fair Reception, N - Noisy Reception, S - Spotty Reception, NS - Noisy and Spotty Reception, NH- Not Heard.

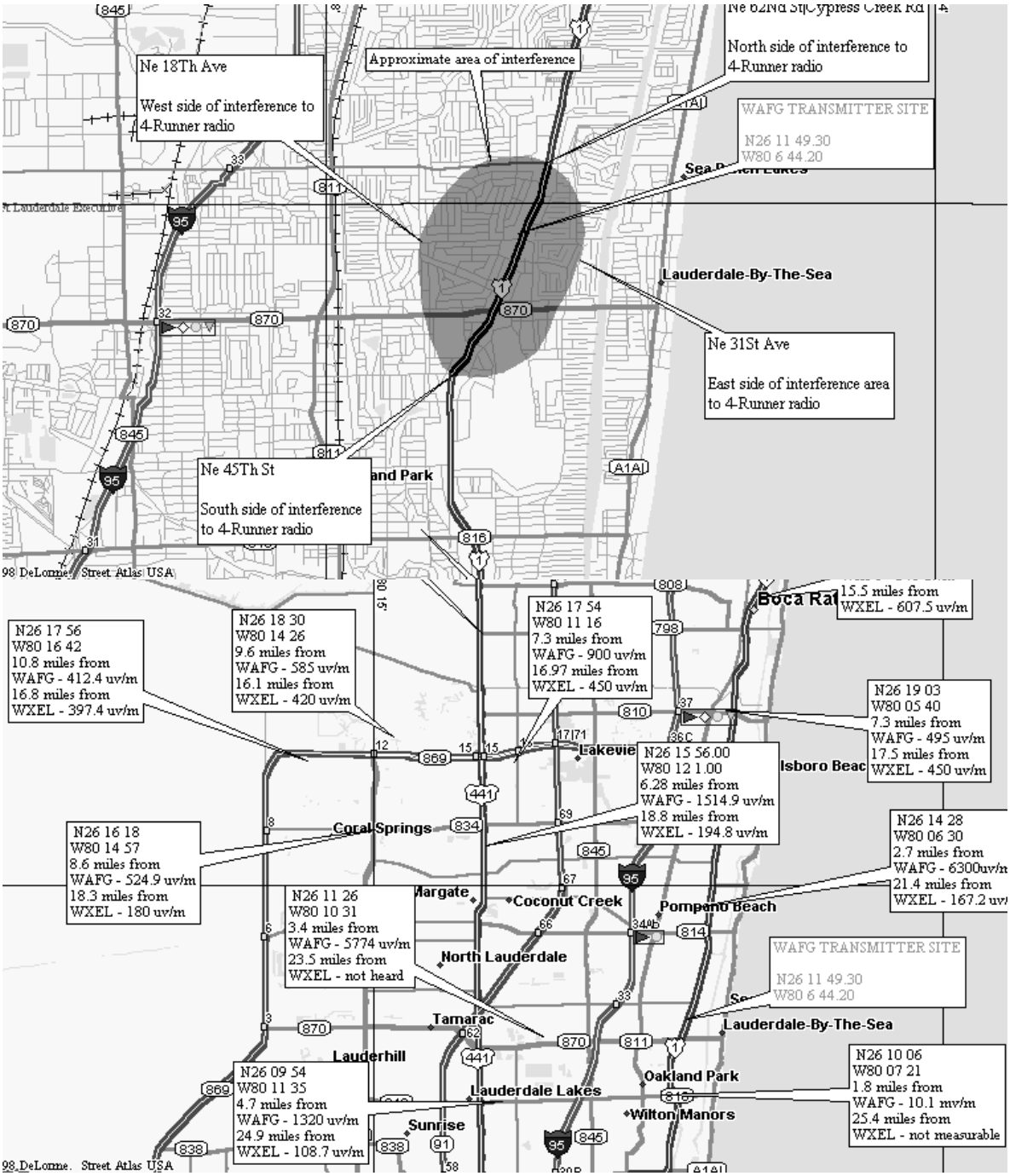
MEASUREMENTS OF 90.7 MHz

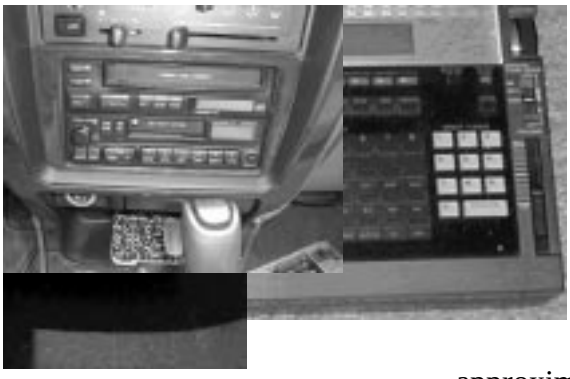
DISTANCE FROM STATION vs SIGNAL STRENGTH

(All measurements in uv/meter)

DISTANCE (Bearing)	AVG. MEAS. VAL.	CORRECTED VAL.	Receivers 1	2	3
2.3(247.9)	11500	25875	G	G	G
5.96(340.1)	1600	3600	G	G	G
8.72(328.8)	1183.3	2662.4	G	G	G
11.23(302.8)	476.6	1072.4	G	G	G
13.42(328.2)	420	945	G	G	G
13.87(351)	246	553.5	G	G	G
15.51(326)	270	607	G	G	G
16.12(359.7)	186.7	420	G	G	G
16.8(6.62)	176.6	397.4	G	G	G
16.97(350.1)	200	450	G	G	G
17.47(333)	200	450	G	G	G
18.32(1.17)	80	180	G	G	G
18.8(353.1)	86.6	194.9	G	G	F
21.4(340.4)	74.3	167.2	G	G	NS
23.46(351.2)	NOT MEAS.		NS	G	S
24.86(353.9)	48.3	108.7	S	G	NS
25.35(345.3)	NOT MEAS		S	G	S

Receiver Notes: G- Good Reception, F - Fair Reception, S - Spotty Reception, NS - Noisy and Spotty Reception


Ne 18Th Ave
West side of interference to 4-Runner radio
Approximate area of interference
Ne 62Nd St/Cypress Creek Rd
North side of interference to 4-Runner radio
WAFG TRANSMITTER SITE
N26 11 49.30
W80 6 44.20
Lauderdale-By-The-Sea
Ne 31St Ave
East side of interference area to 4-Runner radio
Ne 45Th St
South side of interference to 4-Runner radio
98 DeLorme. Street Atlas USA
N26 17 56
W80 16 42
10.8 miles from
WAFG - 412.4 uv/m
16.8 miles from
WXEL - 397.4 uv/m
N26 18 30
W80 14 26
9.6 miles from
WAFG - 585 uv/m
16.1 miles from
WXEL - 420 uv/m
N26 17 54
W80 11 16
7.3 miles from
WAFG - 900 uv/m
16.97 miles from
WXEL - 450 uv/m
15.5 miles from
WXEL - 607.5 uv/m
N26 19 03
W80 05 40
7.3 miles from
WAFG - 495 uv/m
17.5 miles from
WXEL - 450 uv/m
N26 15 56.00
W80 12 1.00
6.28 miles from
WAFG - 1514.9 uv/m
18.8 miles from
WXEL - 194.8 uv/m
N26 16 18
W80 14 57
8.6 miles from
WAFG - 524.9 uv/m
18.3 miles from
WXEL - 180 uv/m
N26 14 28
W80 06 30
2.7 miles from
WAFG - 6300uv/m
21.4 miles from
WXEL - 167.2 uv/
N26 11 26
W80 10 31
3.4 miles from
WAFG - 5774 uv/m
23.5 miles from
WXEL - not heard
WAFG TRANSMITTER SITE
N26 11 49.30
W80 6 44.20
N26 09 54
W80 11 35
4.7 miles from
WAFG - 1320 uv/m
24.9 miles from
WXEL - 108.7 uv/m
N26 10 06
W80 07 21
1.8 miles from
WAFG - 10.1 mv/m
25.4 miles from
WXEL - not measurable
Lakevie
Coral Springs
Margate
Coconut Creek
Pompano Beach
North Lauderdale
Tamarac
Lauderhill
Lauderdale Lakes
Oakland Park
Wilton Manors
Sunrise
98 DeLorme. Street Atlas USA



EQUIPMENT USED IN STUI

RECEIVER 1 - Sony model ICF-2010
approximately 10 years old.

RECEIVER 2 - Toyota 4-Runner Vehicle Receiver
Model 51706 Purchased in June 1996.

Receiver 3 - Sony model CFD-S38 Purchased for this project in April 1999

FIELD STRENGTH METER - Potomac model FIM-71 Serial Number 738R
Calibrated May 13, 1999

GLOBAL POSITIONING SYSTEM RECEIVER - Garmin model GPS-II
Approximately 3 year old.

Mass Media Bureau

Audio Services Division

WAFG FORT LAUDERDALE FL US
212A 90.3 MHz BLED1278 License
Service Class : Full Service FM Station or Application

N Lat 26 11 48
W Lon 80 6 45

Not near the border.

HERP 3.00 kW HHAAT: 85.0 m HRCAMSL: 88.0 m HRCAGL: 86.0 m
VERP 3.00 kW VHAAT: 85.0 m VRCAMSL: 88.0 m VRCAGL: 86.0 m

Non directional
No beam tilt

Plot Site on U.S. Census Tiger Map

Use Browser Back Arrow to return to FM Query.

If you have any corrections to the engineering database or you have discovered an error in the database, please contact Ms. Kim P. Nguyen at 202-418-2700 or send Kim, kpnguyen@fcc.gov an E-mail.

If you have any suggestions about this page please, send your comments to William Ball. wball@fcc.gov

Mass Media Bureau

Audio Services Division

WXEL WEST PALM BEACH FL US
214C1 90.7 MHz BPED990210MB APP
Service Class : Full Service FM Station or Application

N Lat 26 34 37
W Lon 80 14 32

Not near the border.

HERP 50.00 kW HHAAT: 274.0 m HRCAMSL: 274.0 m HRCAGL: 269.0 m
VERP 50.00 kW VHAAT: 274.0 m VRCAMSL: 274.0 m VRCAGL: 269.0 m

Directional Antenna
Make: ODD Model: ODD990210MB
No beam tilt

Plot Site on U.S. Census Tiger Map

JOHN L. THEIMER

Graduated from the University of South Florida in 1969 with a B.S.E.E. Joined the Federal Communications Commission at the Tampa, Fl. Field Office as a staff engineer. During the next 27 years he served in many positions in the Commission=s field organization including Engineer-In-Charge of the Commission=s Buffalo, NY Field Office from 1975 to 1980 and Miami, Fl. Field Office from 1980 until he retired in 1996. Mr Theimer has extensive knowledge in the application of the Federal Communications Commission=s Rules and Regulations and has participated in the resolution of many interference cases over the 27 years of his career. Mr. Theimer is a member of the Institute of Electrical and Electronic Engineers and the Society of Broadcast Engineers.